Carbon Productivity

reimagining carbon
for sustainable value creation

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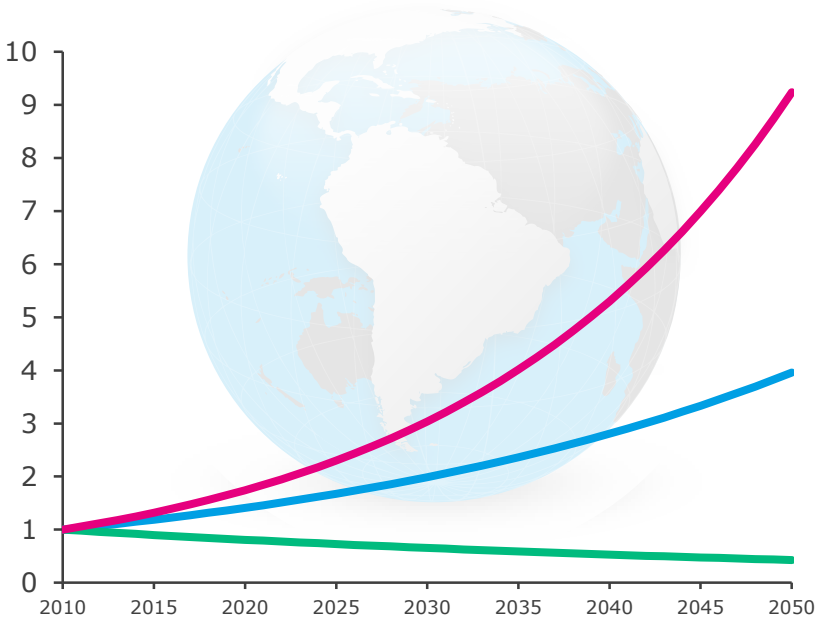
Challenge: Achieving the SDGs AND Paris Climate target…

#reimaginecarbon

To meet 2°C target and SDGs, we need to derive more value from less fossil carbon

10X increase in carbon productivity needed, by 2050

Index: 2010 = 1



Carbon productivity

+5.7% per year

Gross World Product

+3.5% per year (2017)

Fossil Carbon consumption[1]

-2.1% per year

Source: McKinsey Global Institute (2008), OECD GDP forecast, IEA ETP 2014 Emissions forecast (2DS)

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Carbon Productivity

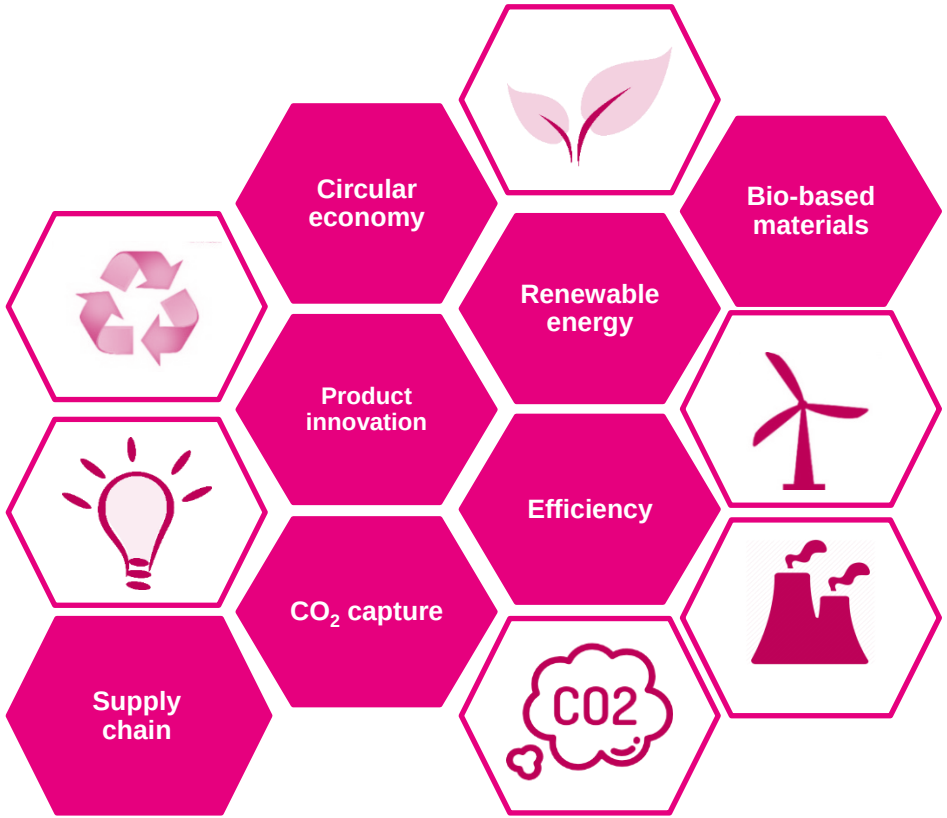
Defining a measurement and improvement tool

Carbon Productivity

Value created

Non-renewable carbon as input for energy and feedstock

www.carbonproductivity.com



Source: SYSTEMIQ

Testing 3 prototype metrics for a suite of scopes

Macro Level

Maximizing value generation from carbon across entire industrial/ regional value chain

Company Level

Decoupling growth from fossil carbon

Transitioning to renewable feedstock, energy and circular economy

Product Level

Reduce fossil carbon consumed with our products

Making most out of carbon at all impact levels

Prototype example: Environmental return on carbon employed (PC car windscreen)

PC glazing has lifetime carbon benefits relative to industry standard

Polycarbonate windscreen compared to laminated glass:

- Light-weighting reduces fuel consumption by 0.11 BOE over life
- After-use recovery of polycarbonate saves 0.02 BOE
- 0.12 BOE to produce one windscreen; 0.05 BOE for glass

Environmental Return on Carbon Employed (EROCE)

$$\frac{\text{Fossil carbon use avoided (Barrels of oil equivalent)}}{\text{Fossil carbon input (Barrels of oil equivalent)}} = \frac{[\,0.11 + (-0.07) + 0.02\,]}{0.12} * 100 \Rightarrow$$

- **0.11**: Use-phase fuel saved compared to glass
- **-0.07**: Adjusted for higher prodn. footprint
- **0.02**: After-use recovery compared to glass
- **0.12**: Barrels of oil equivalent to produce

EROCE=50

Conclusion:

- Product has lifetime carbon benefits relative to the industry standard
- Half of the total fossil carbon consumed in production is “repaid” during use and after use

DRAFT Example: Environmental return on carbon employed (Cardyon: Polyether polyol for mattress)

Recoupling from fossil fuel carbon to captured carbon dioxide

Cardyon* compared to standard Polyol:

- Carbon capture and utilization improving production footprint by 1.8 BOE - Due to the substitution of up to 20wt% of Epoxide with CO_2
- For 1 ton polyol plus 0.36 MWh = 11.0 BOE to produce with Cardyon and; 12.8 BOE with standard PET
- After-use recovery of mattresses do not differ

Environmental Return on Carbon Employed (EROCE)

$$\frac{\text{Fossil carbon consumption avoided (Barrels of oil equivalent)}}{\text{Fossil carbon input (Barrels of oil equivalent)}} = \frac{[\,1.8 + 0.00 + 0.00\,]}{11.0} * 100 \Rightarrow$$

- **1.8**: Better production footprint
- **0.00**: Same use phase benefits
- **0.00**: Same after-use benefits
- **11.0**: Barrels of oil equivalent to produce

EROCE = 16

Conclusion:

- Product has carbon benefits due to lower production footprint
- **16% improvement** in the carbon productivity

*Internal LCA Calculation based on: N, v.d.Assen:Green Chem., 2014, 16, 3272

How to get involved in Carbon Productivity ?

- **Applying, testing, refining** the prototype methodology and metrics
- **Aligning** the carbon productivity concept and tools with methodologies used in your projects / approaches – and vice versa
- **Providing feedback** to Covestro and the Carbon Productivity Consortium

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Thank you for your attention!